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(57) Abstract

The present invention relates to lupin protein compositions, and particularly to lupin protein concentrates and isolates. In particular, the invention relates to oil:water emulsions stabilized by lupin protein compositions and to gels comprising lupin protein compositions.

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TITLE

FUNCTIONAL PROTEIN CONCENTRATES AND ISOLATES

FIELD OF THE INVENTION

The present invention relates to lupin protein compositions, and particularly to lupin protein concentrates and isolates. In particular, the invention relates to oil:water emulsions stabilized by lupin protein compositions and to gels comprising lupin protein compositions.

BACKGROUND OF THE INVENTION

Protein isolates and concentrates

The term "protein concentrate" is a term of art used to define proteinaceous preparations having a protein content of up to about 90% by weight (generally, from 50-90%, typically about 65-70%, by weight) protein. In contrast, the term "protein isolate" is generally reserved for protein preparations containing greater than about 90% by weight protein.

Vegetable protein concentrates and protein isolates are widely used in the food industry. Among the most popular are soya-based products, which find application for example in the manufacture of a wide variety of comminuted meat products (such as burgers and sausages) as well as in certain vegetarian products.

Protein concentrates are generally used simply as protein enrichment ingredients (nutritional adjuncts). However, protein isolates and functional concentrates also exhibit important functional properties. Among the most significant of these functional attributes is the ability to bind fat and water into stable emulsions. These emulsions may be associated with gelling, film forming, texture enhancement and stabilization in foodstuffs.

Another key functional property is the ability to form gels (especially on heating), and particularly stable gels upon cooking in the presence of water.

While it has long been recognized that the functionality of protein isolates is generally superior to that of protein concentrates, isolates are in general more expensive than concentrates. Moreover, several important aspects of the functionality of protein concentrates and isolates vary according to the nature of the protein source.

For example, and as mentioned above, the ability to emulsify high ratio oil:water mixtures at low solids concentrations is a key functional parameter, very important in for example the dairy and related industries. A high degree of functionality in this respect is exhibited by animal-derived protein concentrates and isolates (such as milk-derived proteins, e.g., whey proteins and casein(ate)), as well as by isolates from cereals (such as modified wheat glutens). Similar considerations apply in respect of gel forming functionality.

Unfortunately, the functionality of the widely-available and relatively inexpensive soya protein products or cereal-based proteins in respect of their emulsion-stabilizing and gel-forming activity does not match the performance attainable *via* the use of milk-based products. Moreover, the use of the latter products is associated with quite different problems: lactose intolerance and coeliac disease limits the utility of the milk and cereal

products respectively, and as co-products of dairy or milling processes the base proteinaceous constituents often suffer from supply-chain difficulties (for example, associated with microbiological quality, inconsistent supply etc.).

There is therefore a need for alternative, inexpensive, broadly acceptable and effective functional protein concentrates and isolates.

Lupins and lupin proteins

Lupins have long been recognized as a viable alternative to soya as a source of vegetable protein for human consumption. The lupin plant thrives on agronomically less desirable areas and produces good yields on inferior soil types relative to other legumes. *Lupinus albus*, the white lupin, is the preferred species for cultivation in Europe, while *L. angustifolius* is the species of choice in the less fertile soil of Australia.

It has long been known that the protein content of lupin seeds is equal to that of whole soya beans, and it has been exploited for years as a source of (non-functional) protein in animal feeds.

Moreover, lupin concentrates and isolates *per se* are known (see e.g., WO 97/12524 and EP 0522800, referred to *infra*), and these isolates/concentrates are also known to affect the chemical/physical behaviour of foodstuffs in which they are incorporated (*ibidem*).

However, the present inventors have now unexpectedly discovered that a very high degree of emulsion stabilizing functionality is associated with lupin protein compositions. This extremely useful property has hitherto gone unrecognized. It confers the ability to stabilize emulsions at a higher ratio of oil than is possible with soya protein, and indeed the emulsifying properties approach (or even exceed) those obtainable with the (more expensive and often problematical) animal-derived proteins (such as caseinates).

Strikingly, it has been found that even at relatively low levels of purity (e.g., 35-40%), lupin protein compositions provide an unusually high degree of oil binding capability.

Furthermore, it has also now been found that post-isoelectric precipitation treatment of the lupin protein according to the methods taught in our earlier EP 0522800 (discussed *infra*) yield products (isolates and concentrates) having a stabilizing activity which may equal (or even exceed) that of caseinate (particularly when the lupin protein is present at relatively high levels of purity, for example as a lupin protein isolate at greater than 90% purity). Such post-isoelectric precipitation treated lupin protein products are referred to herein as "restructured" lupin proteins.

SUMMARY OF THE INVENTION

According to the present invention there is provided an emulsion comprising a lupin protein composition, water and fat, wherein the lupin protein is present in an amount sufficient to stabilize the emulsion.

The term "fat" is used herein to include fats which are liquid at room temperatures

(often referred to as oils).

The emulsion may contain any suitable ratio of protein composition:(water plus oil). Typically, the food industry requires emulsions of weight ratio 1:3:6 or 1:5:5 (protein composition (e.g., isolate or concentrate):water:fat), particularly in stabilizing food systems that use high fat and water mixtures, such as comminuted meat products (e.g., sausages) and dairy product replacers. With existing materials, this can generally be achieved by using protein isolates but not by using protein concentrates.

For most food applications, however, it is desirable to keep the solid protein content low relative to the fat and water. Thus, the emulsion preferably comprises 1 part by weight protein composition (dry basis) and: (a) at least 5 parts by weight water and at least 5 parts by weight fat; or (b) at least 10 parts by weight water and at least 20 parts by weight fat; or (c) at least 15 parts by weight water and at least 30 parts by weight fat; or (d) at least 20 parts by weight water and at least 40 parts by weight fat.

Alternatively, the emulsion may comprise 1 part by weight protein composition (dry basis) and: (a) at least 2, 5, 10, 50, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000 or >1000 parts by weight water plus oil (combined).

The ratio of fat to water in the emulsion may vary over a broad range, and may be selected *inter alia* according to the ultimate use to which the emulsion is to be put. In general, high oil:water ratios are desirable (particularly at low solids content - see above), and so preferably the ratio of oil:water is: (a) greater than 1:1; or (b) greater than 3:2; or (c) greater than 2:1; or (d) greater than 5:2; or (e) greater than 3:1.

However, the lupin proteins of the invention have been found to effectively stabilize emulsions containing very high oil:water ratios, for example emulsions wherein the oil:water ratio varies between 2:1 to 1000:1 (or even higher). Thus, particularly preferred are emulsions wherein the ratio of oil:water is selected from any of the ratios: 5:1, 10:1, 100:1, 200:1, 300:1, 400:1, 500:1, 600:1, 700:1, 800:1, 900:1, 1000:1 or >1000:1.

Since it is envisaged that the lupin-based emulsions of the present invention will provide an effective alternative to caseinate, the emulsion of the invention may be formulated such that its fat:water ratio is mimetic of a caseinate-stabilized emulsion. Examples of caseinate-stabilized emulsions include coffee whitener (at a protein:water:fat ratio of 0.8:82.4:11.55) and ice-cream (at a protein:water:fat ratio of 3.6:61:12.5).

The lupin protein content of the lupin protein composition component of the emulsion may vary over a broad range. Those skilled in the art will be able to select the appropriate concentration on the basis of the ultimate application, the physical state of the lupin protein (i.e., whether native, more or less denatured, derivatized, sub-fractionated etc.) and the nature of the oil component.

It will be appreciated that functionality at any given concentration can be readily determined using routine tests.

For most applications, the lupin protein composition will comprise: (a) at least 30% lupin protein; or (b) at least 35% lupin protein; or (c) at least 40% lupin protein; or (d) at least 45% lupin protein; or (e) at least 50% lupin protein; or (f) at least 55% lupin protein; or (g) at least 60% lupin protein; or (h) at least 65% lupin protein; or (i) at least 70% lupin protein; or (j) at least 75% lupin protein; or (k) at least 80% lupin protein; or (l) at least 85% lupin protein; or (m) at least 90% lupin protein; or (n) at least 95% lupin protein.

Particularly preferred for use in the emulsions of the invention are lupin protein concentrates or lupin protein isolates (as hereinbefore defined).

As described in more detail below, the lupin protein for use according to the invention may be provided in any suitable form or physical state. Preferably, it is present in substantially native form, since this is usually associated with higher functionality. It is also preferably debittered, for the reasons described in more detail below.

The lupin protein for use in the invention is preferably prepared by isoelectric precipitation (for example as described below.

Also contemplated by the invention is the emulsion as described above in gelled form (a form which may arise after cooking in a foodstuff).

In another aspect, the invention relates to a gel comprising a lupin protein composition (as hereinbefore defined) and water.

Also covered by the invention are various functional food ingredients comprising the emulsion or gel of the invention. Here, the invention also finds utility as a functional ingredient in various foodstuffs, drinks (e.g., energy or sports drinks) and animal feeds.

For example, the emulsion and/or gel may be used as an ingredient in a babyfood, bakery product (for example, a bread, yeasted good or cake) or bakery supply product (for example, a custard or a bakery filling or topping), a batter or breading, cereal, confectionary, flavour or beverage emulsion, fruit filling, gravy, soup, sauce or food thickener, frozen, chilled or ambient stable gravy, soup, sauce or food thickener, pasteurized, retorted or UHT treated gravy, soup, sauce or food thickener, meal or meal component, e.g., a vegetarian meal/component, meat product (e.g., a comminuted meat product, sausage, burger, grillsteak, canned meat, meat pie, fish, meat spread and paste), petfood, pharmaceutical or neutraceutical, potato product, dairy product (e.g., an ice-cream, dessert, milk drink, milk shake, yoghurt, cheese, cheese spread or dip), dressing (e.g., a salad or low fat dressing), snack or cracker, spread (e.g., savoury or sweet spread), pasta product (e.g., a noodle), fat-filled powder, quiche or flan, textured vegetable protein, vegetarian grillsteak, pate (e.g., vegetarian pate) or spread, vegetable or meat extract, low fat spread, cheese or cream mimetic.

The invention also contemplates cosmetics, for example a cream (e.g., face cream), lipstick, deodorant carrier, lotion, hair gel, soap (e.g., liquid soap) or skin care product (e.g., sun lotion).

In another aspect, the invention relates to a process for the production of an emulsion as hereinbefore defined comprising the steps of: (a) providing a lupin protein composition; (b) mixing the protein composition of step (a) with oil and water; (c) emulsifying the mixture of step (b).

Preferably, the process of the invention is carried out *in situ* within a foodstuff, drink or animal feed during processing thereof. However, it may also be carried out outside a foodstuff (e.g., in vitro) in order to produce an emulsion useful *per se* as a functional food ingredient.

In yet another aspect, the invention relates to a process for the production of a gel as hereinbefore defined comprising the steps of: (a) providing a lupin protein composition; (b) mixing the protein composition of step (a) with water; (c) gelling the mixture of step (b), for example by heating.

In the processes of the invention, step (a) may comprise the step of isoelectrically precipitating lupin protein.

In particularly preferred embodiments, step (a) further comprises the preliminary steps of: (a) providing lupin seeds; and (b) debittering the lupin seeds (e.g., by a two stage extraction as described in WO 97/12524 (PCT/DE 96/01915).

Preferably, the process of the invention further comprises "restructuring" isoelectrically-prepared lupin protein by subjecting isoelectrically precipitated lupin protein to the post-isoelectric precipitation steps of, in the absence of substantial shearing forces: (a) holding an aqueous slurry of the isolectrically-prepared protein at an alkaline pH and a treatment temperature of 75-95 degrees C for 1-120 minutes (e.g., 1 to 60 min); (b) neutralizing the treated slurry e.g., to a pH of 6.8 to 7.0; and optionally (c) evaporating the neutralized slurry and drying it (for example by spray drying).

In this embodiment, the aqueous slurry preferably has a solids content of 12-25% by weight, e.g., 12-17% by weight. Moreover, the alkaline pH is preferably 7.5-9.0 or 9.5, e.g., 7.5-8.5, while the treatment temperature may be 80-95 degrees centigrade, for example about 85 degrees centigrade. In such processes, the structural integrity and/or solubility of the lupin protein may be decreased (at least to some extent) by the treatment (without necessarily compromising, and in some circumstances actually improving, functionality). Thus, the treatment may effect a degree of denaturation of the native lupin proteins (as discussed in our earlier EP 0522800).

DETAILED DESCRIPTION

Lupin proteins for use in the invention

The lupin proteins for use in the invention may be any protein extracted or derived from a member of the genus *Lupinus*, including for example *L. albus* and *L. angustifolius*.

The lupin proteins need not be purified to homogeneity, either with respect to other species of lupin protein present or with respect to other (non-proteinaceous) components.

Indeed, for most applications the lupin protein composition will comprise a heterogeneous mixture of different lupin proteins, including storage proteins, enzymes, structural proteins (including membrane proteins, fibrous proteins and globular proteins), together with contaminating carbohydrate, cellulosic and fatty materials (often in minor amounts).

For some applications, it may be advantageous to subfractionate the lupin protein fraction (for example, to enrich for globulin storage proteins), for example in order to optimize the structural characteristics, solubility, charge or amino acid profile of the lupin protein. It may also be desirable to derivitize or physically modify the lupin protein, for example by (at least partially) denaturing the proteins (e.g., by heating) or by (e.g., partial) enzymic digestion (e.g., protease treatment to yield peptides).

Any of the above approaches can be used to modify the fat/water binding characteristics of the lupin protein and so optimise the emulsion stabilizing properties for any given application.

The lupin proteins may be extracted by any of a variety of standard protein extraction techniques (including those commonly employed in soya bean processing). For most applications, the lupin plants and/or seeds are comminuted (e.g., by milling or grinding) before the extraction processes to enlarge the surface area and maximize yield.

The starting material will usually contain various endogenous enzymes (including lipoxygenases), and these are preferably inactivated prior to further processing. This prevents enzymatic oxidation which can yield persistent rancid tastes and/or odours in the end products. Such inactivation may be achieved for example by blanching (e.g., by steaming), though any other suitable technique may be employed.

Where lupin seeds form part of the starting material, the seeds are preferably pre-processed. This may involve shelling, washing and/or sieving.

Preferably, the lupin proteins are extracted by processes which do not substantially denature the lupin proteins, although lupin protein concentrates containing significant amounts of denatured proteins may be useful in some applications.

In such cases, the concentrates are typically prepared by washing defatted lupin grits with aqueous alcohol in order to remove low molecular weight carbohydrate oligomers and so concentrate the protein fraction of the lupin. The protein is rendered insoluble by the alcohol and retained in a slurry. The slurry is evaporated and dried (e.g., by spray drying or counter-current alcohol extraction). The proteins in the concentrate are to some extent denatured by the alcohol and may also have been damaged by any heat treatment during the defatting process.

More highly functional lupin concentrates may be produced by rendering the proteins insoluble by acid washing at the isoelectric point, so that unwanted carbohydrates are washed away. The less acidic why fraction containing active enzymes is also removed at this stage as a relatively minor protein subfraction. In this process denaturation by alcohol is avoided

and careful defatting to yield defatted grits of high protein dispersibility index (PDI) e.g., in excess of 65 (e.g., in the range 65-80) can minimize damage in the starting material. Protein dispersibility index is defined for example in "Soybeans: Chemistry and Technology", Vol. 1 "Proteins", by A. K. Smith and S. J. Circle, The Avi Publishing Company, Inc., U.S.A. (1972). In this process the native undenatured structure or "vitality" can be retained (in contrast to the alcohol washed concentrates described earlier). The washed slurry may be evaporated and dried as in the alcohol washing process.

Concentrates produced by both these processes contain residual, high molecular weight, insoluble carbohydrates of arabinogalactan composition, concentrated by the process to about 25% by weight.

Highly functional protein isolates may be produced for example by acid washing at the isoelectric point, followed by dissolving the washed slurry in alkali, separating the solid residue containing insoluble carbohydrates from the solution and re-precipitating the protein at e.g., pH 7.0. The products of such processes are referred to herein as isoelectrically-prepared protein products, and the process is referred to as isoelectric precipitation.

Protein of even higher functionality may be obtained by further downstream processing after precipitation, for example as described in our earlier EP 0522800. (The disclosure of the post-isoelectric precipitation steps as defined in the description and claims of this document are incorporated herein by reference.)

In particular, it has now surprisingly been found that the functionality of lupin proteins which have been isoelectrically prepared can be enhanced by the steps of, in the absence of substantial shearing forces: (a) holding an aqueous slurry of the isolectrically-prepared protein at an alkaline pH and a treatment temperature of 75-95 degrees C for 1-120 minutes (e.g., 1 to 60 min); (b) neutralizing the treated slurry e.g. to a pH of 6.8 to 7.0; and optionally (c) evaporating the neutralized slurry and drying it (for example by spray drying).

The aqueous slurry may have a solids content of 12-25% by weight, e.g., 12-17% by weight. The alkaline pH may be 7.5-9.0 or 9.5, e.g., 7.5-8.5. The treatment temperature may be 80-95 degrees centigrade, for example about 85 degrees centigrade. The solubility of the lupin protein may be somewhat decreased by the treatment.

However, it has also surprisingly been found that *untreated* lupin protein concentrates (even containing low concentrations, such as 35-40% lupin protein on a dry weight basis) provide an unusually high degree of oil binding activity.

Lupin anti-nutrient removal

Lupin protein often contains so-called anti-nutrients. These constituents may be toxic, unpalatable or induce undesirable consequences during digestion (such as flatulence). They include bitter constituents (such as alkaloids) and certain sugars (including oligosaccharides).

The lupin proteins for use in the invention are preferably free from these anti-nutrients, and so the proteins are preferably processed such that anti-nutrients are removed.

Many different processes are available for removing the anti-nutrients (often referred to in the art as "debittering treatments"), and those skilled in the art will readily be able to effect a suitable protocol. For example, the lupin protein may be treated by the two stage extraction processes disclosed in WO 97/12524 (PCT/DE 96/01915) (the teaching of which is incorporated herein by reference).

EXAMPLES

EXAMPLE 1: POULTRY SKIN EMULSION

The high fat binding characteristics of lupin protein make it ideally suited to the production of poultry skin emulsions. Typically, poultry skin emulsions are used as a cheap filler within reformed poultry products such as poultry burgers.

4 kg of poultry skin are chopped in a bowlcutter at high speed for 15 seconds. The cutter speed is then set to slow speed and 0.5 kg of a lupin protein concentrate (ca. 60% lupin protein) and 2.0 kg of water are added. The chopping is continued for two minutes on high speed until a smooth glossy emulsion has been formed. The emulsion is then chilled and used as an ingredient in a poultry burger.

EXAMPLE 2: FRANKFURTER

1.75 kg pork belly 50 vl, 1.5 kg pork shoulder 80 vl and 0.5 kg of beef flank 70 vl are ground in a mincer with a 10 mm plate. The ground meats are then placed in a mixer together with 0.05 kg of lupin protein concentrate (ca. 60% lupin protein), 0.9 kg water, 0.1 kg curing salt and 0.1 kg seasoning, and mixed for two minutes.

0.1 kg of potato starch is then added and mixing continued for a further minute. The mix is then passed through an emulsion mill with a 0.5 mm plate and filled into casings. The products are steam cooked at 80 degrees Centigrade to an internal temperature of 72 degrees Centigrade, then cooled and peeled.

EXAMPLE 3: NON-DAIRY SPREAD

7 kg of rape, soya and palm fat blend are heated to 45 degrees Centigrade and 0.1 kg of dairy flavour mixed in. 0.8 kg of lupin isolate (ca. 90% lupin protein) is added to 2.1 kg of water and heated to 80 degrees centigrade. This liquid phase is then slowly added to the oil phase using a Y-Tron homogenizer. The mixture is then poured into containers and chilled.

CLAIMS

1. An emulsion comprising water, fat and a lupin protein composition present in an amount sufficient to stabilize the emulsion, characterized in that the lupin protein composition comprises less than 65% lupin protein and includes other non-proteinaceous lupin components.

2. The emulsion of Claim 1 wherein the fat is present in an amount high enough to impart a firm (e.g., cream- or cheese-like) texture to the emulsion.

3. The emulsion of Claim 1 or Claim 2 wherein the lupin protein composition is a lupin extract comprising a heterogeneous mixture of different lupin proteins together with contaminating carbohydrate, cellulosic and/or fatty materials.

4. The emulsion of any one of Claims 1-3 wherein the lupin protein composition comprises:

(a) up to 30% lupin protein; or
(b) up to 35% lupin protein; or
(c) up to 40% lupin protein; or
(d) up to 45% lupin protein; or
(e) up to 50% lupin protein; or
(f) up to 55% lupin protein; or
(g) up to 60% lupin protein.

5. The emulsion of any one of the preceding claims wherein the lupin protein composition comprises 35-40% lupin protein.

6. An emulsion comprising:

(a) a lupin protein composition;
(b) water; and
(c) fat,

the lupin protein composition comprising being present in an amount sufficient to stabilize the emulsion.

7. The emulsion of any one of the preceding claims comprising 1 part by weight protein composition (dry basis) and:

(a) at least 5 parts by weight water and at least 5 parts by weight fat; or
(b) at least 10 parts by weight water and at least 20 parts by weight fat; or
(c) at least 15 parts by weight water and at least 30 parts by weight fat; or
(d) at least 20 parts by weight water and at least 40 parts by weight fat; or
(e) at least 2, 5, 10, 50, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000 or >1000 parts by weight water plus oil (combined).

8. The emulsion of any one of the preceding claims wherein the ratio of fat:water in the emulsion is at least (or greater than):

(a) 1:1; or
(b) 3:2; or
(c) 2:1; or
(d) 5:2; or
(e) 3:1; or
(f) 7:2; or
(g) 4:1;

or varies between 2:1 to 1000:1 or >1000:1 or is selected from any or the ratios: 5:1, 10:1, 100:1, 200:1, 300:1, 400:1, 500:1, 600:1, 700:1, 800:1, 900:1, 1000:1 or >1000:1.

9. The emulsion of any one of the preceding claims having a fat:water ratio mimetic of a milk protein- (e.g., caseinate-) stabilized emulsion.

10. The emulsion of any one of the preceding claims wherein the protein composition comprises:

(a) up to or at least 30% lupin protein; or
(b) up to or at least 35% lupin protein; or
(c) up to or at least 40% lupin protein; or
(d) up to or at least 45% lupin protein; or
(e) up to or at least 50% lupin protein; or
(f) up to or at least 55% lupin protein; or
(g) up to or at least 60% lupin protein; or
(h) up to or at least 65% lupin protein; or
(i) up to or at least 70% lupin protein; or
(j) up to or at least 75% lupin protein; or
(k) up to or at least 80% lupin protein; or
(l) up to or at least 85% lupin protein; or
(m) up to or at least 90% lupin protein; or
(n) up to or at least 95% lupin protein.

11. The emulsion of any one of Claims 6-10 wherein the protein composition is a lupin protein concentrate.

12. The emulsion of any one of Claims 6-10 wherein the protein composition is a lupin protein isolate.

13. The emulsion of any one of the preceding claims wherein the lupin protein is:

(a) in substantially native form; and/or
(b) is debittered.

14. The emulsion of any one of the preceding claims wherein the lupin protein is an isoelectrically precipitated lupin protein.

15. The emulsion of Claim 14 wherein the lupin protein comprises a restructured lupin protein.

16. The emulsion of any one of the preceding claims in gelled form.

17. A gel comprising a lupin protein or lupin protein composition as defined in any one of the preceding claims and water.

18. A functional food ingredient comprising the emulsion or gel of any one of the preceding claims.

19. A foodstuff, drink (e.g., energy or sports drink) or animal feed comprising the emulsion or gel of any one of Claims 1 to 18.

20. The foodstuff of Claim 19 which comprises:

(a) a babyfood; or

(b) a bakery product (for example, a bread, yeasted good or cake) or bakery supply product (for example, a custard or a bakery filling or topping); or

(c) a batter or breading; or

(d) a cereal; or

(e) a confectionary; or

(f) a flavour or beverage emulsion; or

(g) a fruit filling; or

(h) a gravy, soup, sauce or food thickener; or

(i) a frozen, chilled or ambient stable gravy, soup, sauce or food thickener; or

(j) a pasteurized, retorted or UHT treated gravy, sauce or food thickener; or

(k) a meal or meal component, e.g., a vegetarian meal/component; or

(l) a meat product (e.g., a comminuted meat product, sausage, hot dog, burger, grillsteak, canned meat, meat pie, fish, meat spread and paste); or

(m) a petfood; or

(n) a pharmaceutical or neutraceutical; or

(o) a potato product; or

(p) a dairy product or mimetic (e.g., an ice-cream, dessert, milk drink, milk shake, yoghurt, cheese, processed cheese, cheese spread or dip); or

(q) a dressing (e.g., a salad or low fat dressing), e.g., having a protein composition:water:fat ratio of about 1:20:70); or

(r) a snack or cracker; or

(s) a spread (e.g., savoury or sweet spread); or

(t) a pasta product (e.g., a noodle); or

(u) a fat-filled powder (e.g., having a protein composition:water:fat ratio of about 1:20:23); or

(v) a quiche or flan; or

(w) a textured vegetable protein; or

(x) a vegetarian grillsteak; or

(y) a pate (e.g., vegetarian pate) or spread (e.g., having a protein composition:water:fat ratio of about 1:20:25); or

(z) a vegetable or meat extract; or

(a') a low fat spread, cheese or cream mimetic; or

(b') a coffee whitener (e.g., having a protein composition:water:fat ratio of about 1:22:12); or

(c') a soup (e.g., having a protein composition:water:fat ratio of about 1:10-15:12-36).

21. A cosmetic comprising the emulsion or gel of any one of Claims 1 to 17, the cosmetic for example being:

(a) a cream (e.g., face cream); or

(b) a lipstick; or

(c) a deodorant carrier; or

(d) a lotion; or

(e) a hair gel; or

(f) a soap (e.g., liquid soap); or

(g) a skin care product (e.g., sun lotion).

22. A process for the production of an emulsion as defined in any one of Claims 1 to 17 comprising the steps of:

(a) providing a lupin protein composition;

(b) mixing the protein composition of step (a) with oil and water;

(c) emulsifying the mixture of step (b).

23. A process for the production of a gel as defined in Claim 17 comprising the steps of:

(a) providing a lupin protein composition;

(b) mixing the protein composition of step (a) with water;

(c) gelling the mixture of step (b), for example by heating.

24. The process of Claim 22 or 23 which is carried out *in situ* within a foodstuff, drink or animal feed during processing thereof (e.g., during mixing, homogenization, cooking or heating thereof).

25. The process of Claim 22 or Claim 23 wherein step (a) comprises the step of isoelectrically washing and/or precipitating lupin protein.

26. The process of Claim 25 wherein step (a) further comprises the preliminary steps of:

(a) providing lupin seeds;

(b) debittering the lupin seeds.

27. The process of any one of Claims 24 to 26 further comprising restructuring the isoelectrically precipitated lupin protein by the post-isoelectric precipitation steps of, in the absence of substantial shearing forces:

(a) holding an aqueous slurry of the isolectrically-prepared protein at an alkaline pH and a treatment temperature of 75-95 degrees C for 1-120 minutes (e.g., 1 to 60 min);

(b) neutralizing the treated slurry e.g. to a pH of 6.8 to 7.0; and optionally

(c) evaporating the neutralized slurry and drying it (for example by spray drying).

28. The process of Claim 27 wherein the aqueous slurry has a solids content of 1-25% (for example 12-25%, e.g., 12-17%) by weight.

29. The process of Claim 27 or Claim 28 wherein the alkaline pH is 7.5-9.0 or 9.5, e.g., 7.5-8.5.

30. The process of any one of Claims 27-29 wherein the treatment temperature is 80-95 degrees centigrade, for example about 85 degrees centigrade.

31. The process of any one of Claims 27-30 wherein the solubility of the lupin protein is decreased by the treatment.

32. An emulsion or foodstuff, drink or feed obtainable by the process of any one of Claims 22-31.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/17727

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A23J3/14 A23L1/314 A23D7/00 A23L2/66 A23K1/16
A61K7/48

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A23J A23L A23D A23K A21D A23G A23C A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	J. MANRIQUE ET AL.: "The effect of lupin protein isolation procedures on the emulsifying and water-binding capacity of a meat-protein system" JOURNAL OF FOOD TECHNOLOGY, vol. 11, no. 4, 1976, pages 409-422, XP002088710 gb see page 409, Summary see page 410, paragraph 1 - paragraph 2 see page 419, paragraph 4 - page 421, paragraph 2 see tables 1-7 --- -/--	1-14,19, 20,32

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
23 December 1998	12/01/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dekeirel, M

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INTERNATIONAL SEARCH REPORT

Ir. .ational Application No
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International Application No
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X	R. THOMPSON & R. CASEY: "Perspectives for peas and lupins as protein crops" 1983 , MARTINUS NIJHOFF , THE HAGUE, NL XP002068535 see page 328, paragraph 1 - page 333, last paragraph --- -/--	6,16,17

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/17727

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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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